



(12) **United States Patent**
Olch et al.

(10) **Patent No.:** **US 9,476,251 B2**
(45) **Date of Patent:** **Oct. 25, 2016**

(54) **WATER-TIGHT COMPARTMENT WITH
REMOVABLE HATCH AND TWO-SIDED
GEL SEAL FOR MULTIPLE CONDUIT
ACCESS**

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/239,749**

(22) PCT Filed: **Jun. 15, 2012**

(86) PCT No.: **PCT/US2012/042673**

§ 371 (c)(1),
(2), (4) Date: **Sep. 9, 2014**

(87) PCT Pub. No.: **WO2013/109305**

PCT Pub. Date: **Jul. 25, 2013**

(65) **Prior Publication Data**

US 2015/0040484 A1 Feb. 12, 2015

Related U.S. Application Data

(60) Provisional application No. 61/525,489, filed on Aug.
19, 2011.

(51) **Int. Cl.**
E06B 7/23 (2006.01)
B63B 19/14 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **E06B 7/2314** (2013.01); **B63B 17/00**
(2013.01); **B63B 19/14** (2013.01); **B63B 19/26**
(2013.01); **B63B 25/00** (2013.01); **B64C 1/00**
(2013.01);

(Continued)

(58) **Field of Classification Search**

CPC F16J 13/14; F16J 13/12; F16J 13/02;
B65D 45/18; B65D 45/16; B65D 45/02;
B65D 2543/00444; E06B 7/2314; E06B
7/2305; B64C 1/00; B63B 25/00; B63B
17/00; E02D 29/14

USPC 220/326, 324, 315, 328, 327, 795, 780,
220/806, 796; 277/648, 644; 49/463-466,
49/483.1, 495.1; 244/129.4, 129.1

See application file for complete search history.

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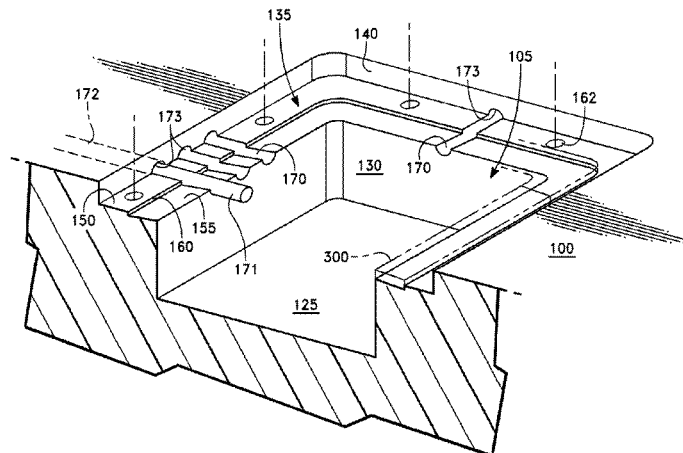
Primary Examiner — Justin Rephann

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(57) **ABSTRACT**

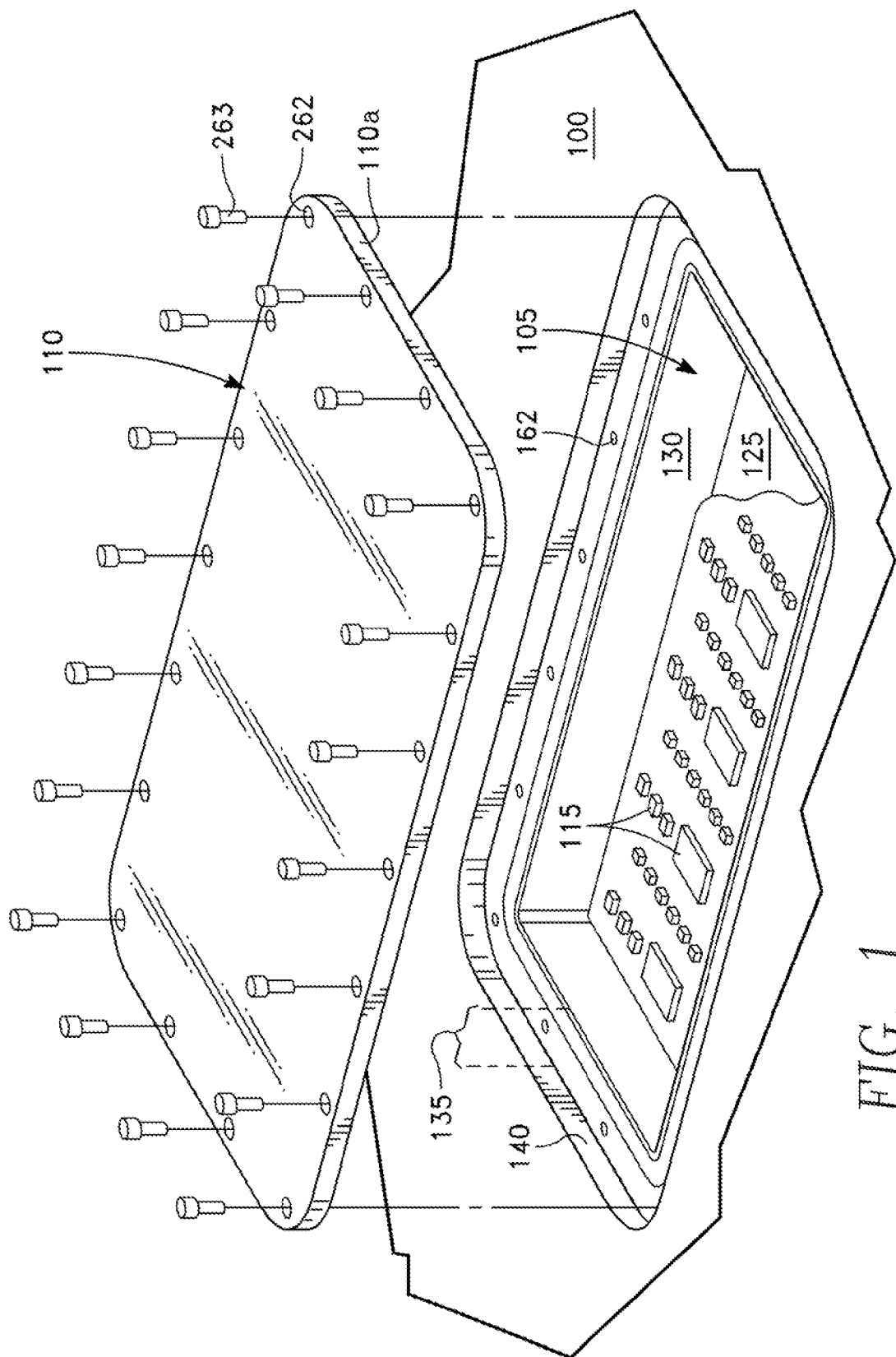
A water-tight or air-tight accessible compartment has a
removable hatch sealed at the edge with elastically conform-
able opposing seals, with elongate communication elements
extending into the compartment between the opposing seals,
seals conforming to the topology formed between the com-
partment edge and the elongate communication elements.

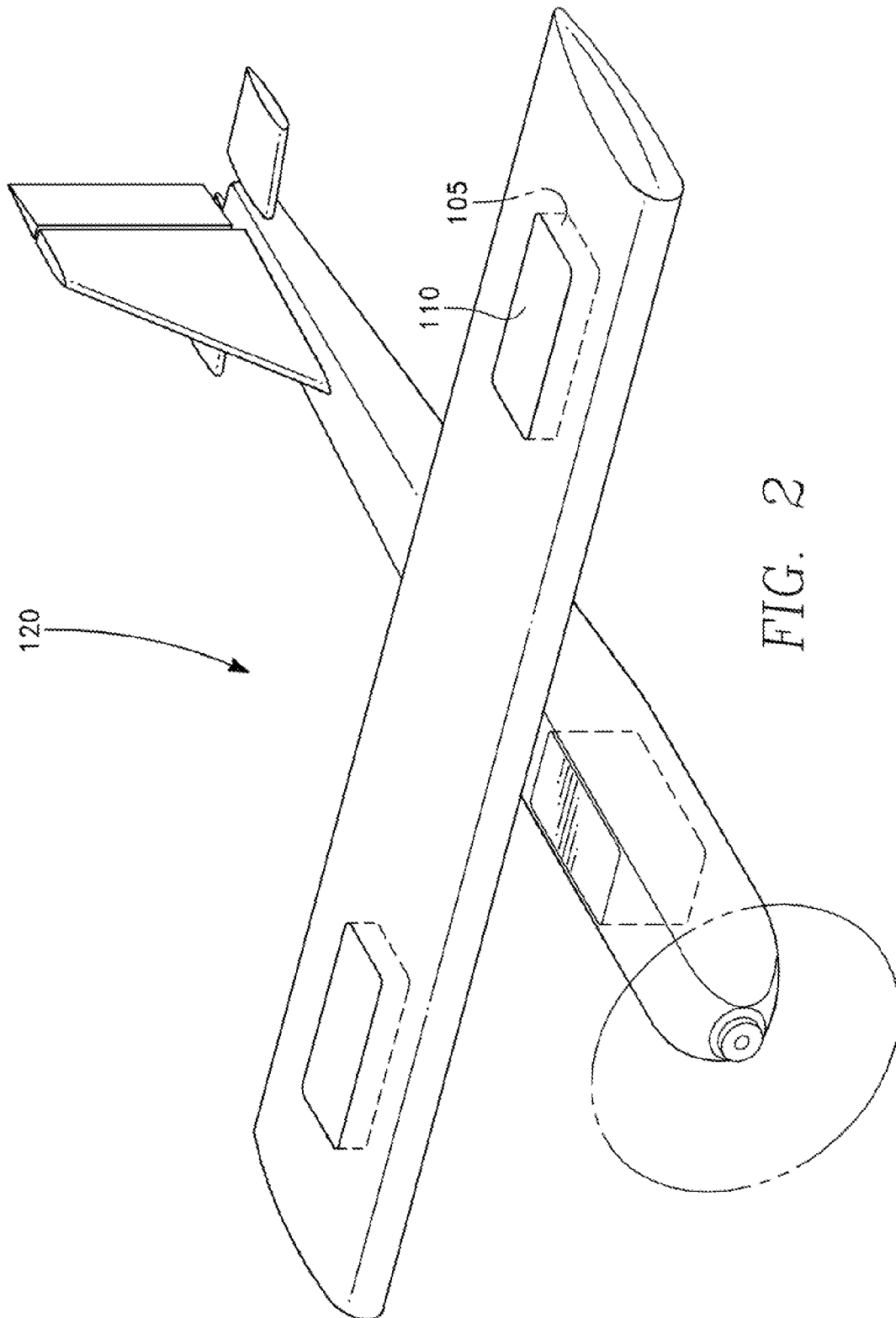
18 Claims, 16 Drawing Sheets



- (51) **Int. Cl.**
B63B 19/26 (2006.01)
H05K 5/06 (2006.01)
B64C 1/14 (2006.01)
B63B 17/00 (2006.01)
B63B 25/00 (2006.01)
B64C 1/00 (2006.01)
E02D 29/14 (2006.01)
E06B 7/28 (2006.01)
- (52) **U.S. Cl.**
 CPC **B64C 1/1446** (2013.01); **B64C 1/1461** (2013.01); **E02D 29/14** (2013.01); **E06B 7/2305** (2013.01); **E06B 7/28** (2013.01); **H05K 5/069** (2013.01)
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- International Searching Authority; Written Opinion of the International Searching Authority (WO) for corresponding PCT case application No. PCT/US2012/042673 entitled Water-tight compartment with removable hatch and two-sided gel seal for multiple conduit access by Olch et al.; mailed Jan. 25, 2013 from US International Searching Authority; 10 pgs.
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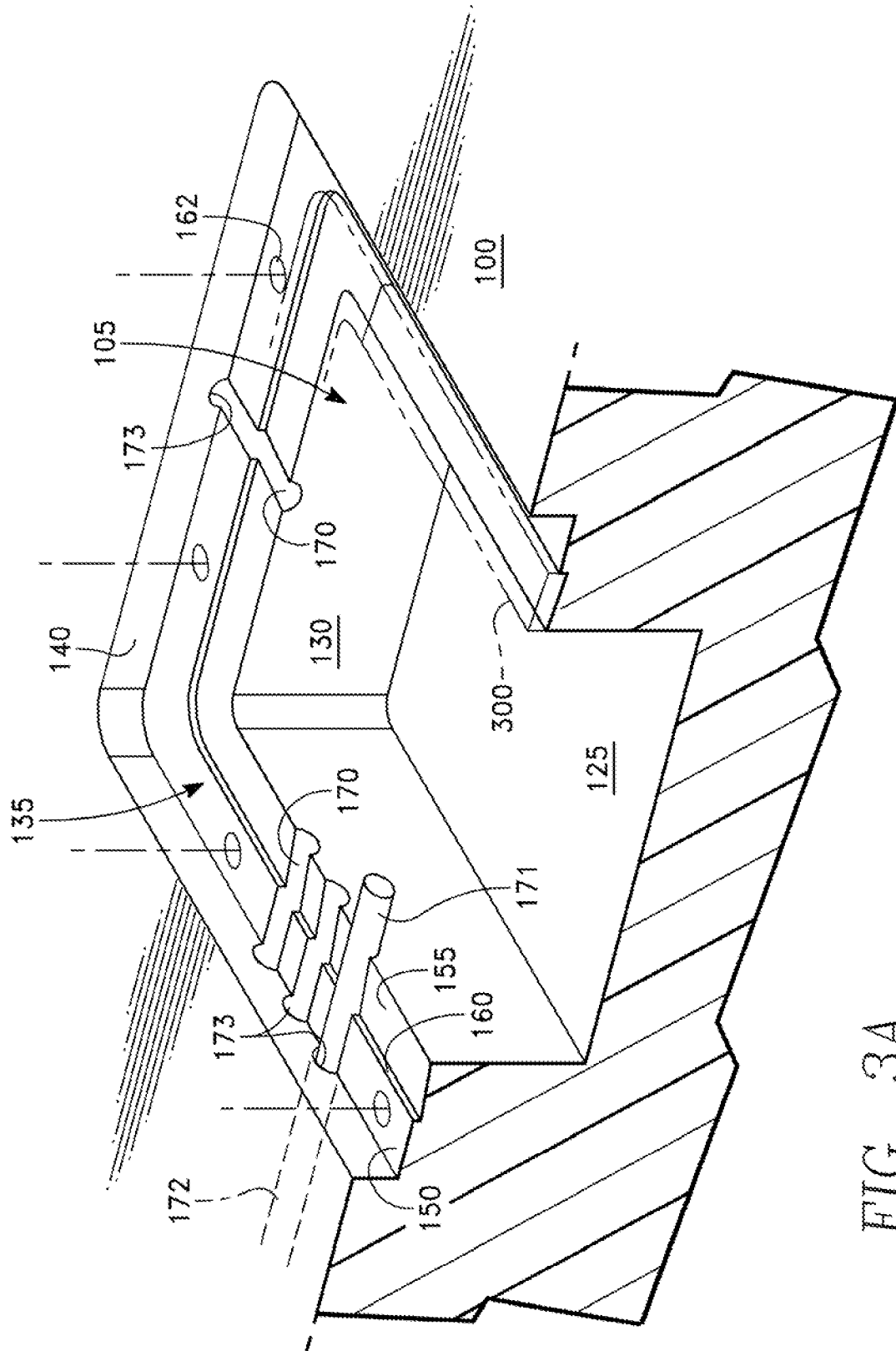


FIG. 3A

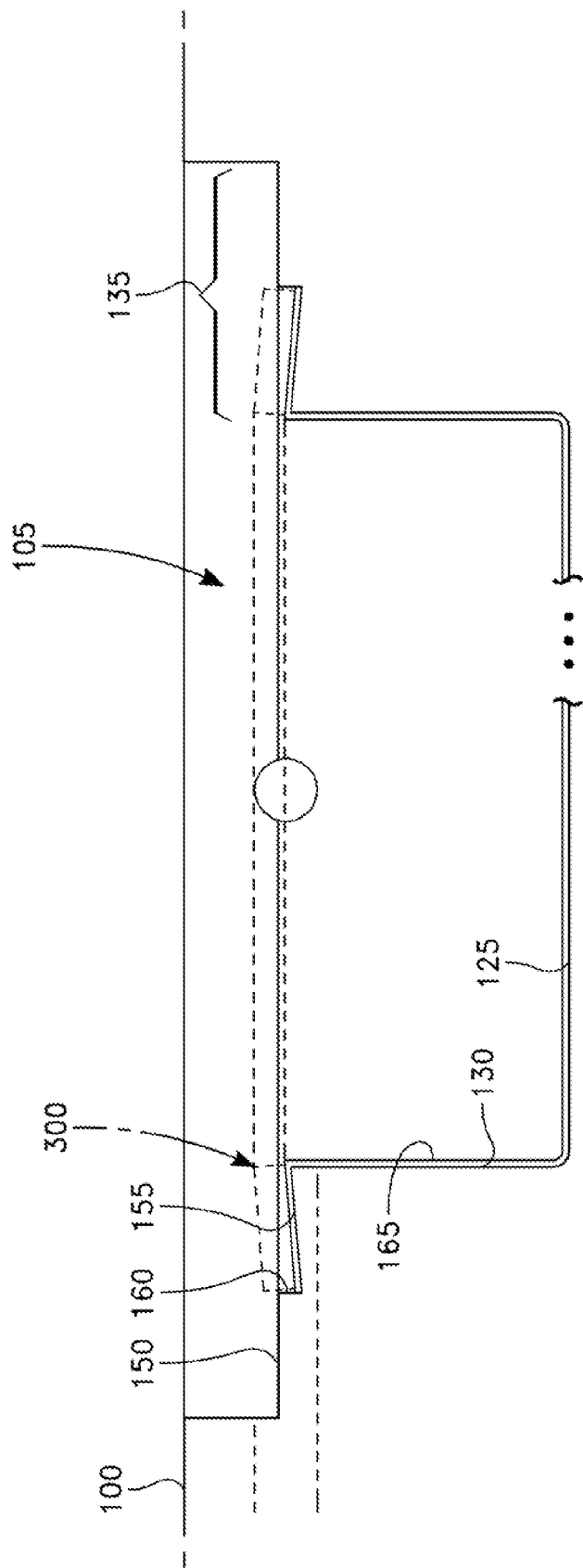


FIG. 3B

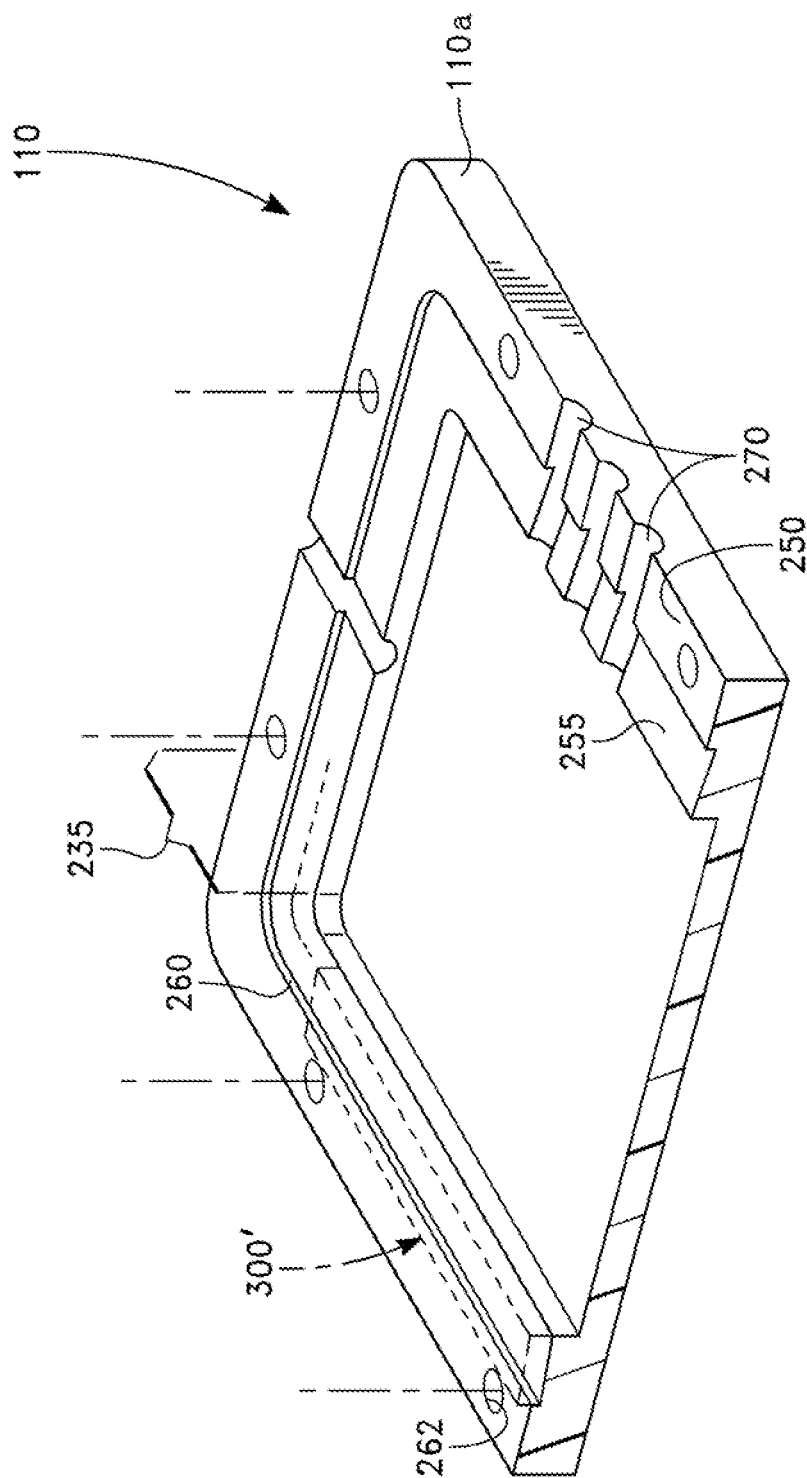
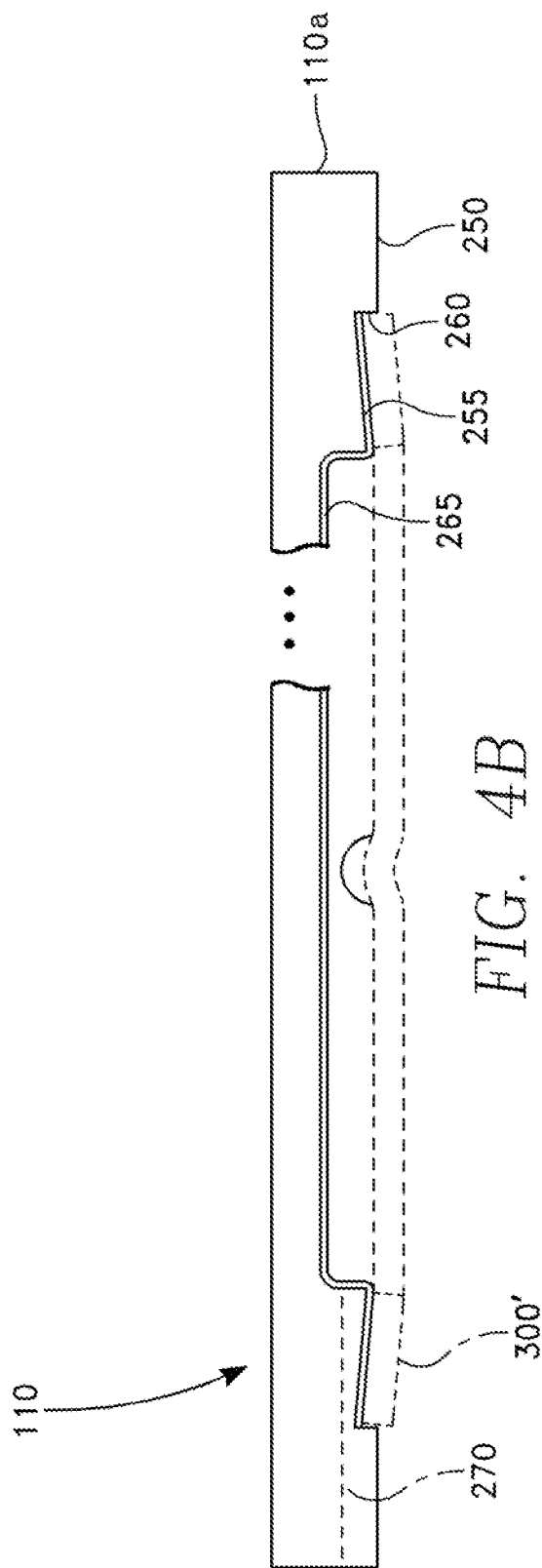


FIG. 4A



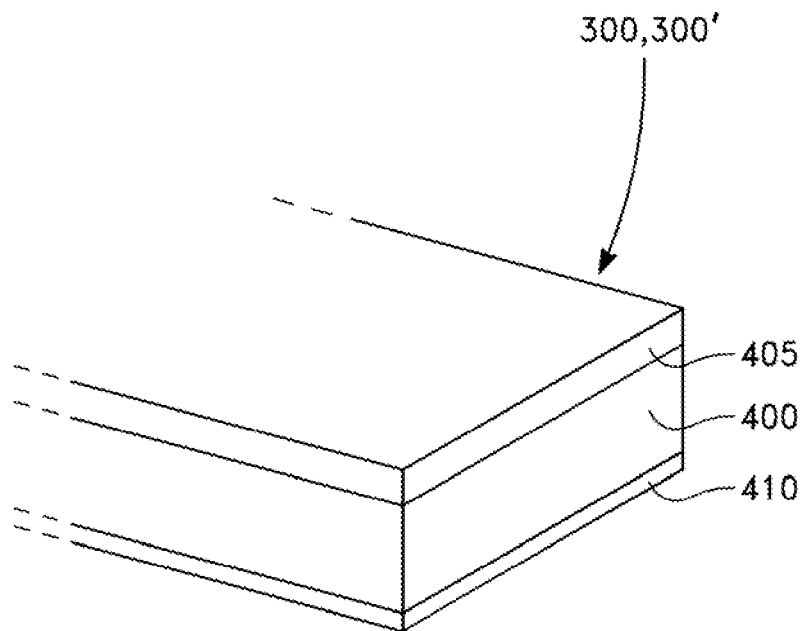


FIG. 5

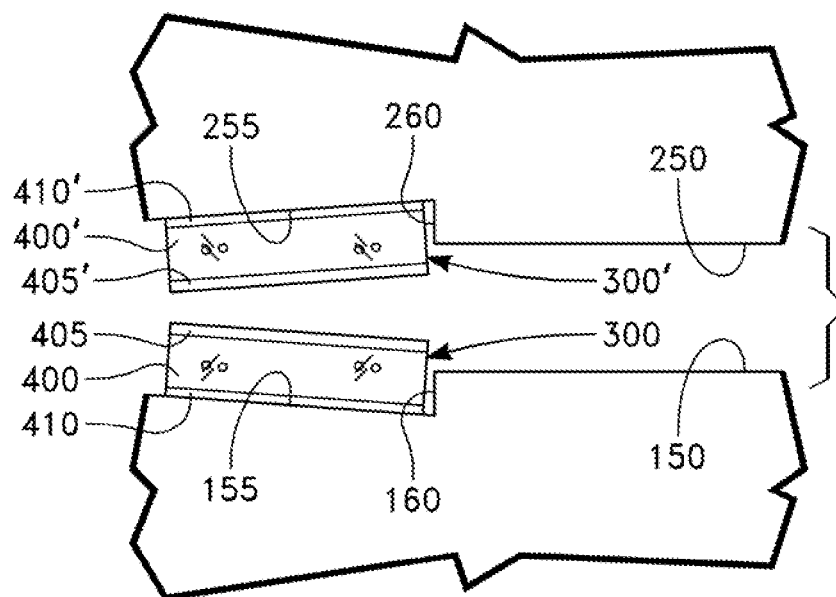


FIG. 6

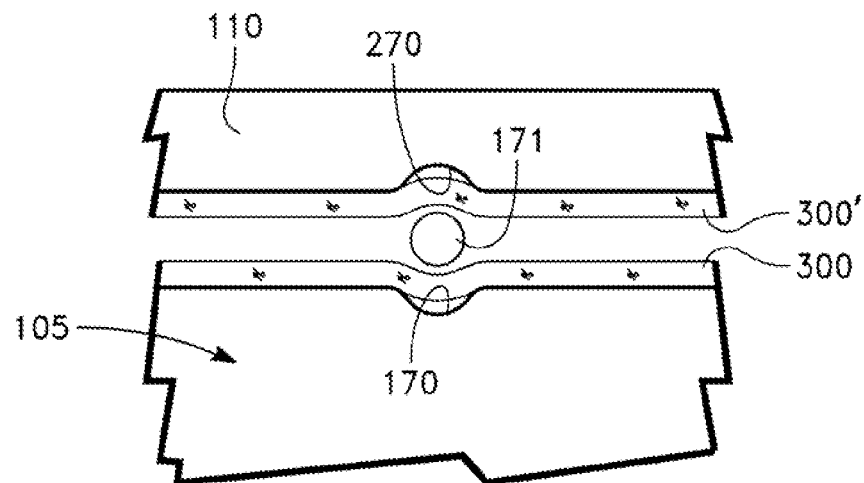


FIG. 7A

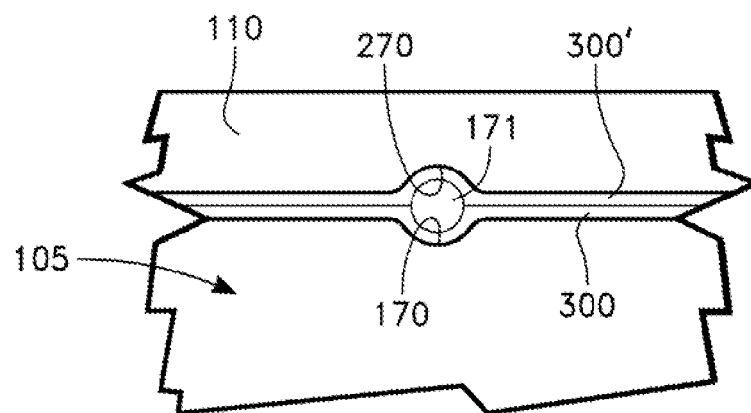


FIG. 7B

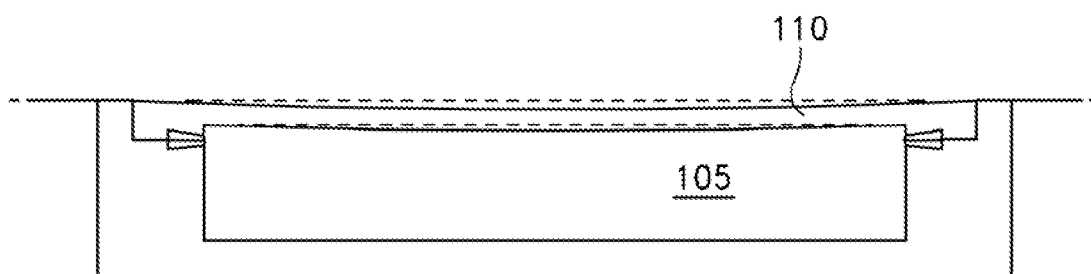


FIG. 7C

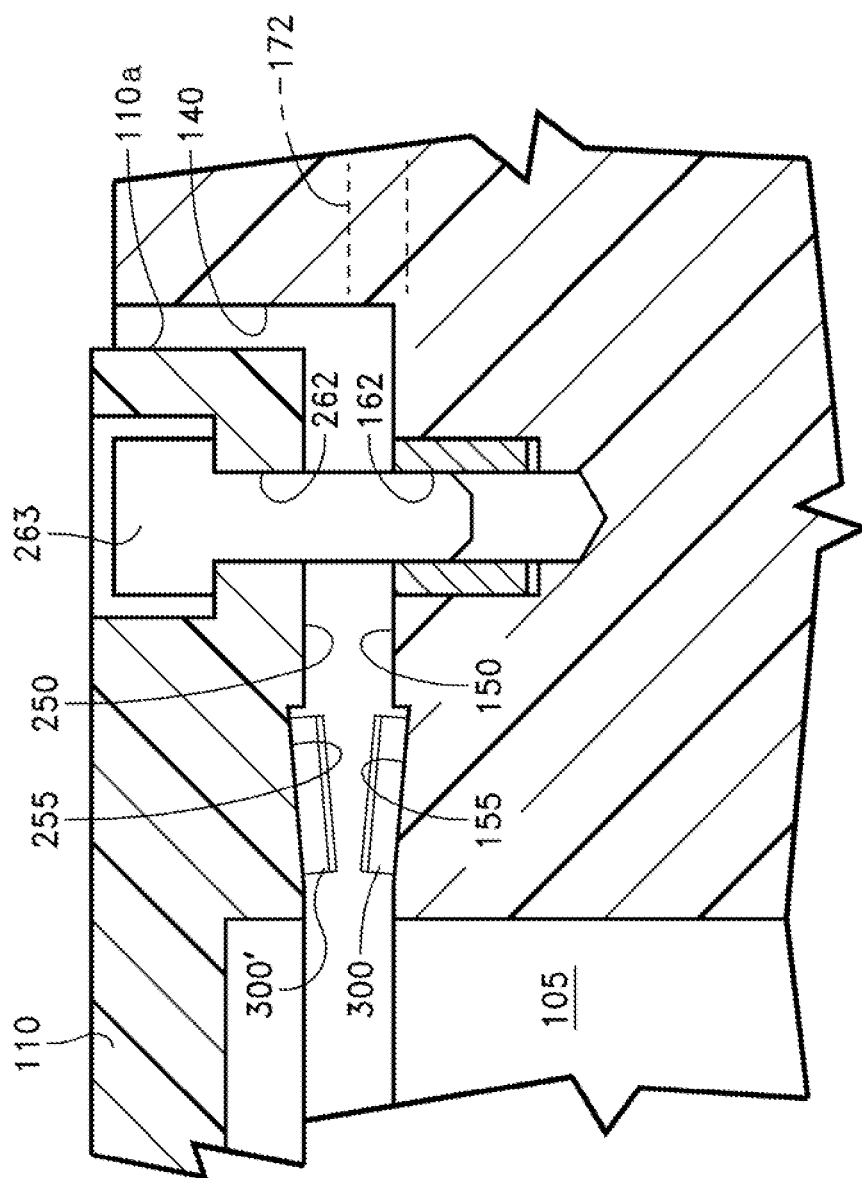


FIG. 8

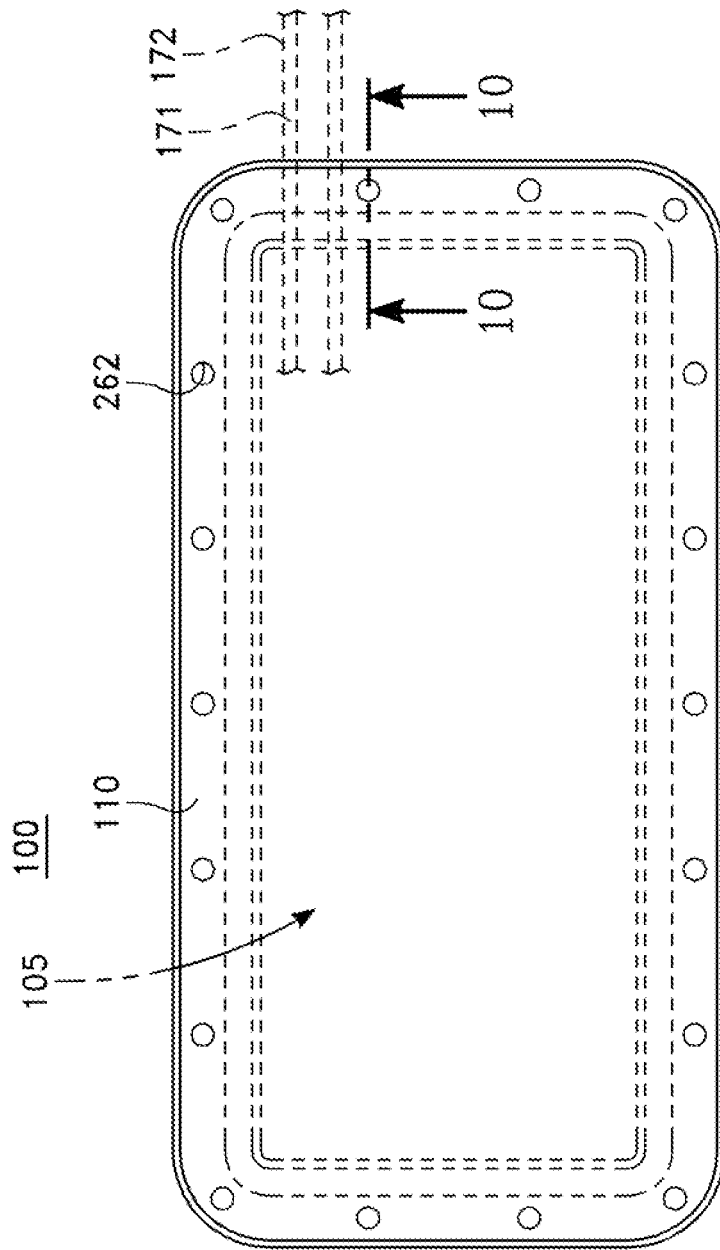


FIG. 9

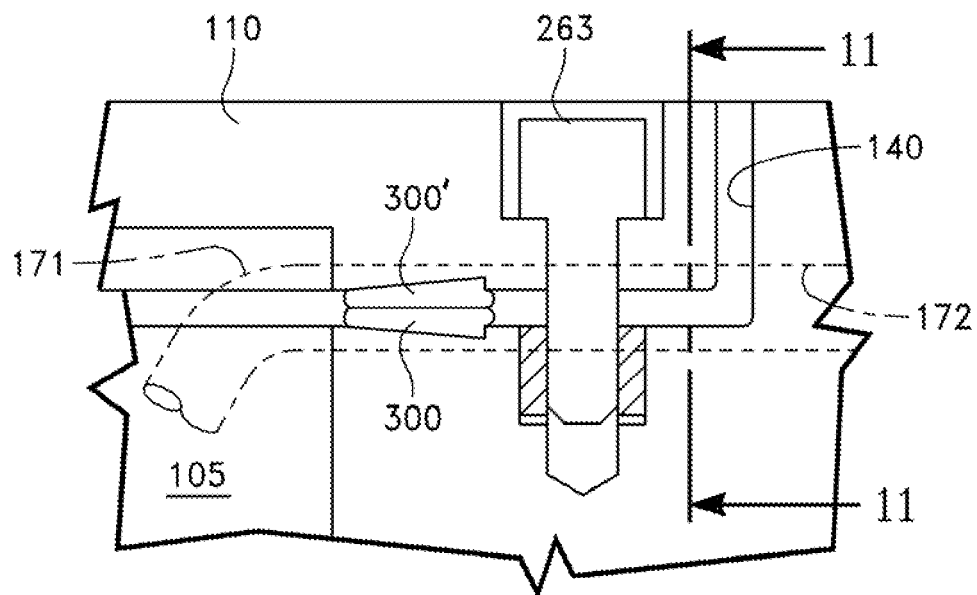


FIG. 10

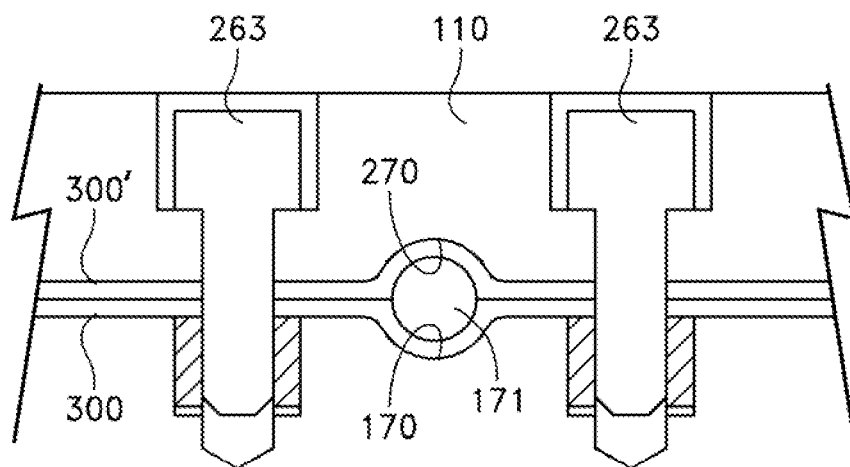


FIG. 11

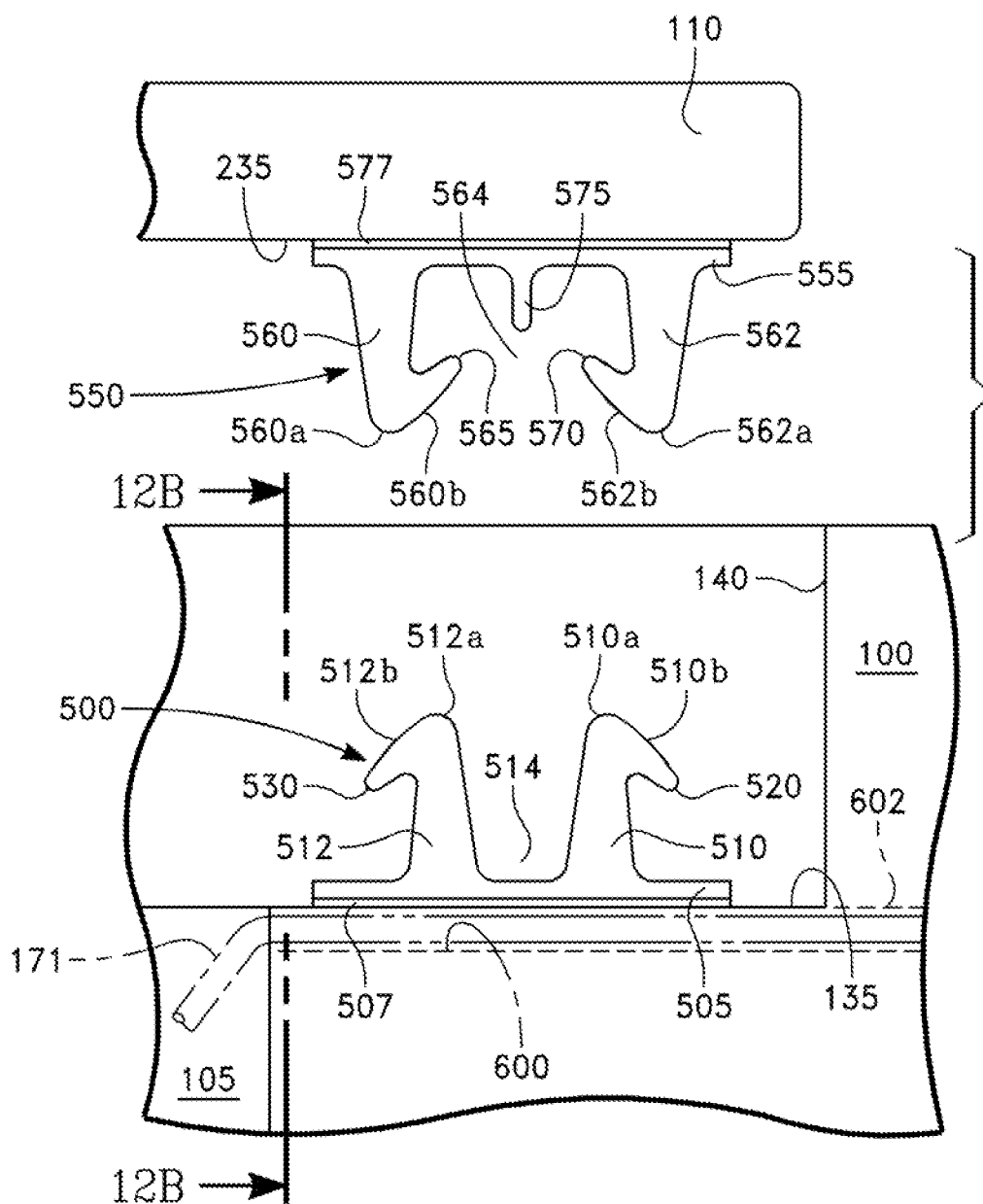


FIG. 12A

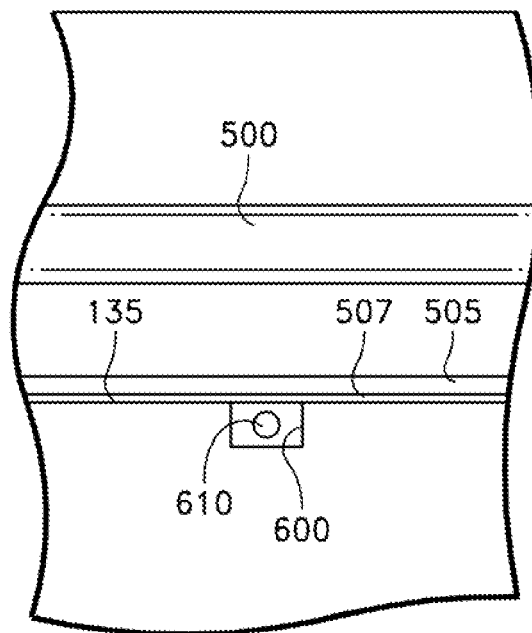


FIG. 12B

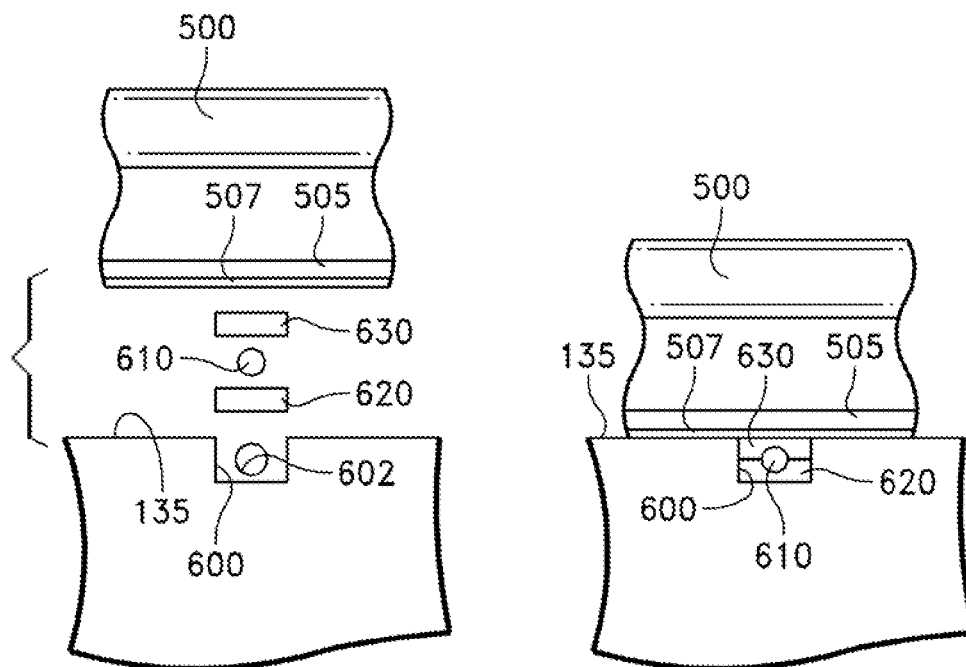


FIG. 12D

FIG. 12E

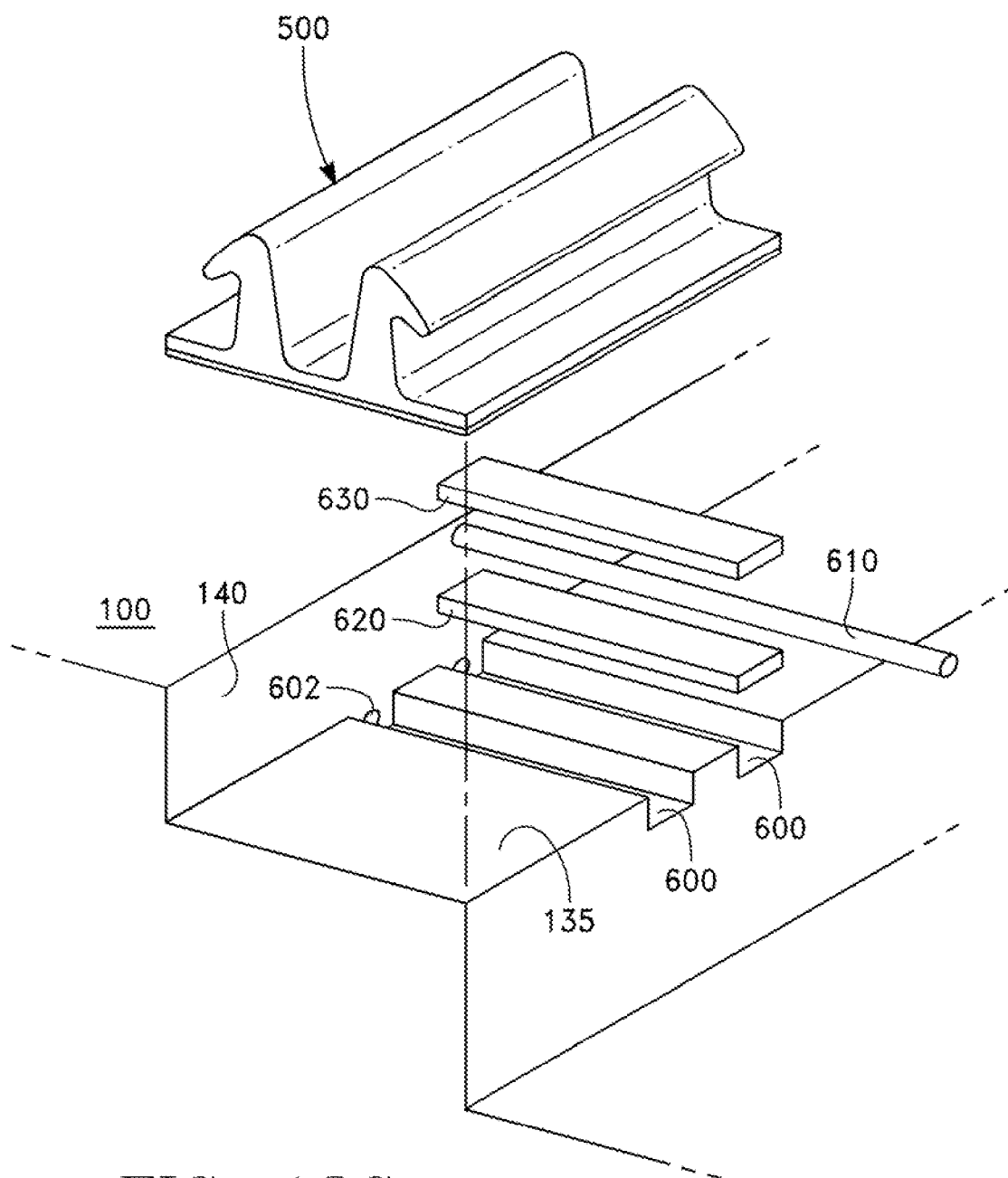


FIG. 12C

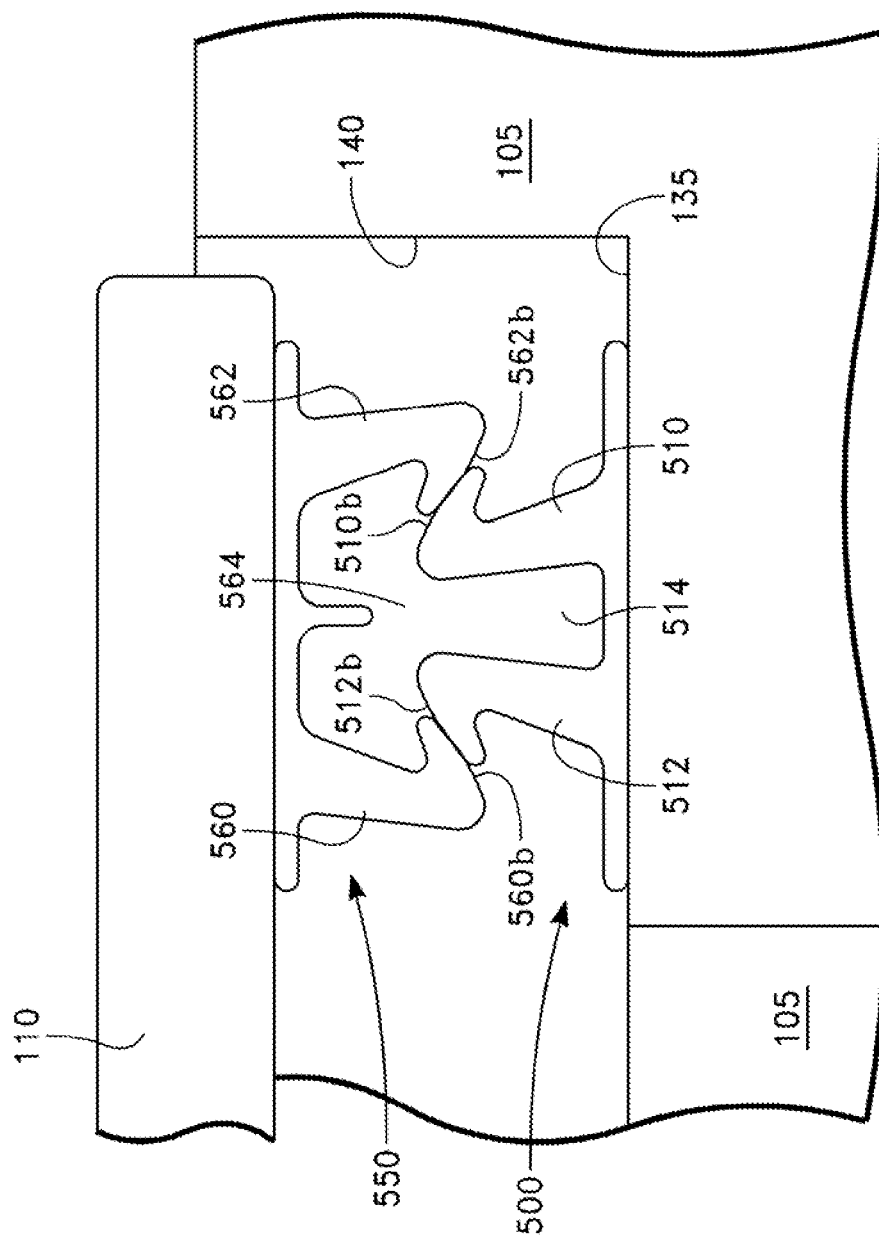


FIG. 13

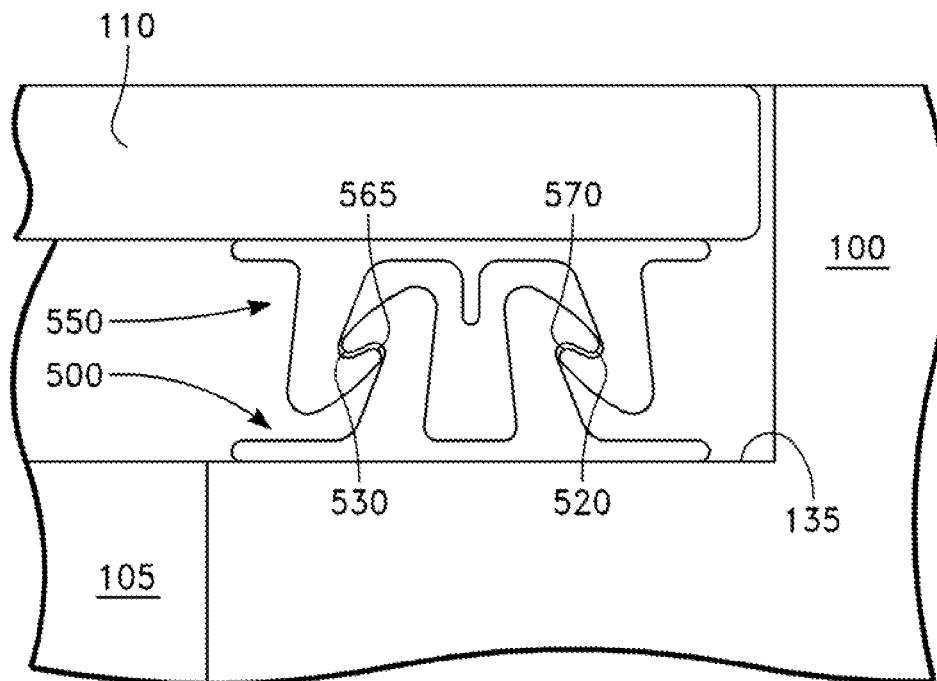


FIG. 14

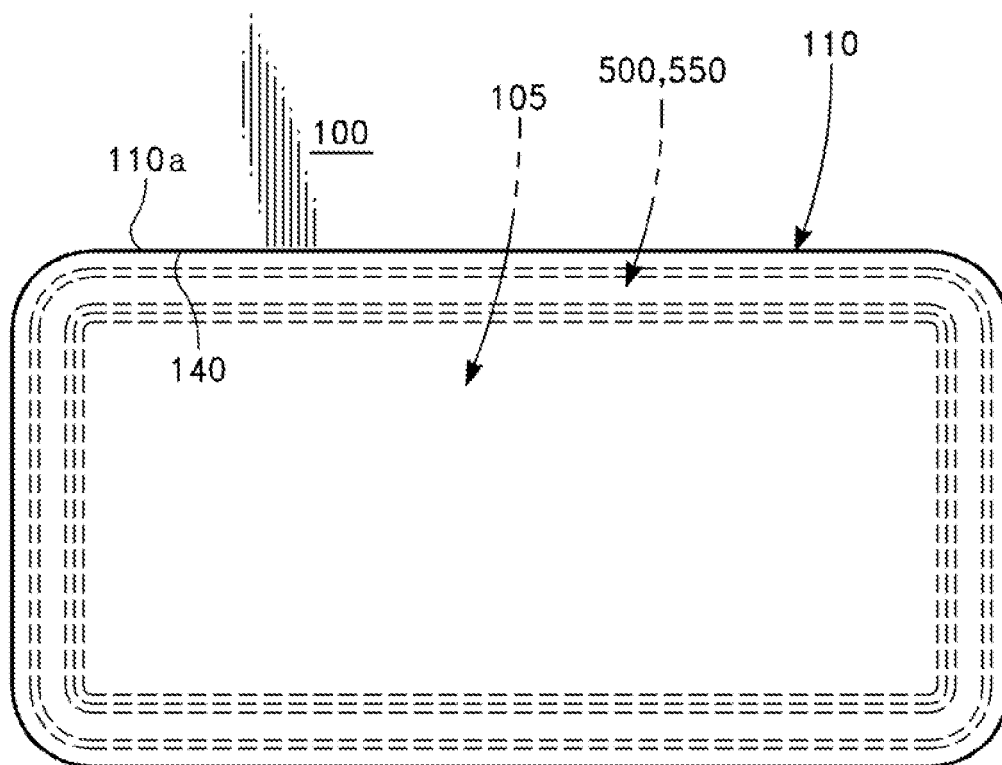


FIG. 15

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WATER-TIGHT COMPARTMENT WITH REMOVABLE HATCH AND TWO-SIDED GEL SEAL FOR MULTIPLE CONDUIT ACCESS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of U.S. Provisional Application Ser. No. 61/525,489 filed Aug. 19, 2011 entitled WATER-TIGHT COMPARTMENT WITH REMOVABLE HATCH AND TWO-SIDED GEL SEAL FOR MULTIPLE CONDUIT ACCESS, by Ronald H. Olch, et al.

BACKGROUND

Aircraft and water vessels ("craft") containing on-board electronics can require accessible water-tight compartments to house, for example, on-board electronic components. As employed herein, the term "water-tight" is understood to refer to resistance to diffusion or flow of liquid or gas molecules through a boundary or envelope, the gas being oxygen or air, or the liquid being water, for example. Such a water-tight compartment typically is enclosed by a water-proof envelope, and includes a removable hatch that is tightly fastened over the top of the compartment. It is desirable that the hatch may be removed and re-installed repeatedly, while attaining a water-tight or air-tight seal with the compartment upon each re-installation. The outermost surface of the hatch is typically flush with the outer surface of the craft, to present an aerodynamically smooth overall surface. Such a water-tight compartment may have conduits passing between the interior of the water-tight compartment and other locations on the craft external of the water-tight compartment. Each conduit may accommodate various wires, fiber optic cables and tubes. This enables communication between the electronics contained inside the water-tight compartment and other elements on the craft. Each such conduit must penetrate the water-proof envelope of the water-tight compartment, and therefore entails a risk of leakage around the interface between the conduit and the water-proof envelope. This is particularly true in cases where a water landing cools the interior of the water-tight compartment, thereby creating a vacuum that pulls moisture in through any small voids that may exist at the interface between the water-proof envelope and any of the conduits passing through the water-proof envelope. Such problems can be addressed by using a special mechanical seal fitting at each one of the conduits. Such an approach may be undesirable due to the complexity, cost and weight entailed in such mechanical seal fittings. What is needed is a way of preventing leakage through the water-tight envelope around the various conduits without requiring special mechanical seal fittings.

SUMMARY OF THE INVENTION

An accessible compartment is provided in the body of a craft such as an aircraft or water craft, the body having an exterior body surface, the sealed compartment comprising a side wall and a floor defining a compartment interior, a compartment sealing surface at a top edge of the side wall, and a hatch body with a hatch sealing surface facing the compartment sealing surface. One or more elongate communication elements lie adjacent the compartment sealing surface and extend into the compartment interior from locations outside of the compartment interior. A first sealing

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gasket is between the compartment sealing surface and the hatch sealing surface and comprises a first elastically conformable layer. The compartment further includes hatch-to-compartment fastening structure. In an embodiment, the first gasket is between the compartment sealing surface and the elongate communication member, the compartment further comprising a second gasket between the hatch sealing surface and the elongate communication member, the second gasket comprising a second elastically conformable layer. In an embodiment, a first non-adhesive layer covers the first elastically conformable layer and a second non-adhesive layer covers the second elastically conformable layer. In an embodiment, a sloped portion of the compartment sealing surface and a sloped portion of the hatch sealing surface are ramped with respect to each other so as to open away from each other along a direction away from the compartment interior. In an embodiment, the conformable material has a conformability corresponding to an exclusion size on the order of a liquid molecule or a gas molecule. In an embodiment, the gasket comprises an underlying gasket attached to the compartment sealing surface and an overlying gasket attached to the hatch sealing surface.

In accordance with another aspect, an accessible sealable compartment in a body having an exterior body surface comprises a compartment interior and a compartment sealing edge adjacent a top edge of the compartment interior; a hatch body having a hatch sealing surface congruent with and facing the compartment sealing surface; and a pair of interlocking gaskets comprising a first interlocking gasket on the compartment sealing edge and a second interlocking gasket on the hatch sealing edge, the first and second interlocking gaskets comprising an elastically deformable material. In an embodiment, the compartment further comprises one or more channels in the compartment sealing edge and underlying the first interlocking gasket, the channels being in communication with the compartment interior; and one or more elongate communication members having respective portions lying in the respective channels, the elongate communication members extending into the compartment interior from locations outside of the compartment interior. In an embodiment, the compartment further comprises a sealing gasket in each channel surrounding the respective elongate communication member, the sealing gasket comprising an elastically conformable material. In an embodiment, the sealing gasket comprises a first gasket underlying the elongate communication member and a second gasket overlying the elongate communication member. In an embodiment, the elastically conformable material comprises a viscous gel. In an embodiment, the elastically conformable material has a conformability corresponding to an exclusion size on the order of a liquid molecule such as water or a gas molecule such as oxygen. In an embodiment, the channel has a width corresponding to a diameter of the elongate communication member. In an embodiment, one of the interlocking gaskets comprises a pair of elongate outwardly extending barbs and the other of the interlocking gaskets comprises a pair of elongate inwardly extending barbs mateable with the pair of elongate outwardly extending barbs.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the exemplary embodiments of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended

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drawings. It is to be appreciated that certain well known processes are not discussed herein in order to not obscure the invention.

FIG. 1 is a perspective view of a sealable compartment including a removable hatch, in accordance with an embodiment.

FIG. 2 is a perspective view of the compartment of FIG. 1 on the wing of an aircraft.

FIG. 3A is a cross-sectional perspective view of the compartment of FIG. 1.

FIG. 3B is a cross-sectional side view corresponding to FIG. 3A.

FIG. 4A is a cross-sectional perspective view of the removable hatch of FIG. 1.

FIG. 4B is a side view corresponding to FIG. 4A.

FIG. 5 is a perspective view of a layered structure of a sealing gasket in the embodiment of FIG. 1.

FIG. 6 is a cut-away side view of portion of an assembly of the compartment and removable hatch of FIG. 1.

FIG. 7A is a cut-away end view of a portion of the assembly of FIG. 1 in the vicinity of a channel and elongate communication element before the removable hatch is fully pressed to the compartment.

FIG. 7B is a cut-away end view of a portion of the assembly of FIG. 1 in the vicinity of a channel and elongate communication element when the removable hatch is fully pressed to the compartment.

FIG. 7C is a side view corresponding to FIG. 7B.

FIG. 8 is a side cross-sectional view corresponding to FIG. 7A.

FIG. 9 is a plan view corresponding to FIG. 1.

FIG. 10 is a cross-sectional view taken along lines 10-10 of FIG. 9.

FIG. 11 is a cross-sectional view taken along lines 11-11 of FIG. 10.

FIG. 12A is a cut-away end view of a second embodiment in a partially disassembled state.

FIG. 12B is a cross-sectional view taken along lines 12B-12B of FIG. 12A.

FIG. 12C is a perspective view corresponding to FIG. 12A.

FIG. 12D is a cut-away side view corresponding to FIG. 12A.

FIG. 12E is a cut-away side view corresponding to FIG. 12C of the second embodiment in an assembled state.

FIG. 13 is a cut-away end view depicting the embodiment of FIG. 12A in a partially assembled state.

FIG. 14 is a cut-away end view depicting the embodiment of FIG. 12A in a fully assembled state.

FIG. 15 is a top view corresponding to FIG. 14.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation. It is to be noted, however, that the appended drawings illustrate only exemplary embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

DETAILED DESCRIPTION

FIG. 1 is an orthographic view of a surface 100 of a craft (such as an aircraft or vessel) having a water-tight compartment 105 sealed in accordance with one embodiment described below in greater detail. A removable hatch 110

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provides access to the compartment 105 for servicing various electronic components 115 contained in the compartment 105. FIG. 2 depicts an example of how the compartment 105 and hatch 110 may be provided on the wing of an aircraft 120. The external surface of the hatch 110 is flush with the surface of the wing. The compartment interior is defined by a floor 125 and a sidewall 130. The sidewall 130 is surrounded by a shoulder 135 whose surface is depressed below the outer surface 100 to form a step 140. The surface of the shoulder 135 forms an elongate strip that follows the outline of the compartment 105. In the illustrated embodiment, the compartment 105 is generally rectangular, and the surface of the shoulder 135 forms a rectangular annulus. If the compartment 105 were circular or ellipsoidal, then the shoulder 135 would be in the shape of a circular or ellipsoidal annulus, for example. The height and shape of the step 140 matches (or approximately matches) the thickness of outer edge 110a of the hatch 110. Referring to the enlarged view of FIG. 3A, the shoulder 135 is divided into an outer surface or strip 150 and an inner surface or strip 155 depressed below the outer surface 150 to form a ridge 160 between them. As will be explained later in this specification, the ridge 160 exists because the inner surface 155 is ramped relative to the outer surface 150. The ridge 160 is a generally vertical surface facing the interior of the compartment 105. In the illustrated embodiment, the outer and inner surfaces 150, 155 are each a generally rectangular annulus, in accordance with the shape of the shoulder 135. Plural fastener openings 162 are provided through the outer surface 150 of the shoulder 135.

The body of the craft forming the surface 100 and the surfaces of the floor 125 and the sidewall 130 may be formed of a composite material such as a molecular fiber matrix and fiberglass composite, which may be a Kevlar® material. Kevlar® is a registered trademark of E. I. du Pont de Nemours and Company, of Wilmington, Del. and the Kevlar® material is offered through a website of that corporation. Such a material may be water penetrable. Therefore, as shown in FIG. 3B, a thin waterproof layer or film 165 is deposited on the interior surfaces of the compartment, including the floor 125 and sidewall 130, so that the layer 165 adheres to the underlying surfaces. This seals the floor 125 and side wall 130 of the compartment 105. The film 165 may possibly extend over the top of the sidewall 130 and onto the interior surface 155 of the shoulder 135. Otherwise, the film 165 may extend to the top edge of the sidewall 130. The film 165 functions as a water-proof envelope of the compartment 105 and may be formed of a complaint material such as Surlyn® material. Surlyn® is a registered trademark of E. I. du Pont de Nemours and Company, of Wilmington, Del. and the Surlyn® material is offered through a website of that corporation.

Referring again to FIG. 3A, conduits for wires, optical fibers, tubes or the like passing into the compartment 105 are accommodated by channels 170 formed in the outer and inner surfaces 150, 155 of the shoulder 135. Each individual channel 170 is transverse to the path of the shoulder 135 and may be sized to accommodate a single elongate communication element. Each elongate communication element 171 may be a flexible member such as a wire conductor, optical fiber, tube, conduit or the like. For example, the depth of each channel 170 may be about one half of the diameter or thickness of the elongate communication element 171 to be accommodated. As will be described below in this specification, the hatch 110 has similar channels in registration with the channels 170 in the shoulder 135, each channel in the hatch 110 having a similar depth. While FIG. 3A depicts

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examples in which the flexible members **171** are elongate and/or cylindrical, the flexible members may be wide and planar in shape, such as a ribbon cable, or flat rectangular items such as flex circuits as well as single-conductor cables, tubes, and the like. In each case, the channels are shaped appropriately, to be congruent with the wide planar shape as required.

Ingress of the elongate communication element **171** into the body of the craft is provided by an internal passageway **172** terminated at a hole or opening **173** in the vertical wall of the step **140**. The opening **173** of the internal passageway **172** is in registration with the channel **170**. Respective internal passageways **172** and holes **173** are provided for the respective channels **170**, as depicted in FIG. 3A. Each hole **173** has a diameter of about twice the depth of the channel, and the channel **170** is aligned with the bottom half of the hole **173**. As will be described below in this specification, the top half of the hole **173** faces a corresponding channel in the hatch **110**.

Referring to FIG. 4A, the interior surface of the hatch **110** has a structure mirroring the structure of the compartment **105** described above with reference to FIG. 3A. Specifically, the hatch edge **110a** surrounds a hatch shoulder **235** formed in the interior (bottom) surface of the hatch **110**, the shoulder **235** of the hatch **110** being congruent with the shoulder **135** of the compartment **105**. The shoulder **235** is divided into an outer surface or strip **250** and an inner surface or strip **255** depressed below the outer surface **250** to form a ridge **260** between them. The ridge **260** is a generally vertical surface facing the interior of the compartment **105**. The outer surface **250** accommodates fastener openings **262**. Fasteners **263**, such as threaded screws, may pass through the openings **262** in the hatch **110** and be threadably engaged in the openings **162** in the body of the compartment **105**, as seen in FIG. 1.

The body of the hatch **110** may be formed of a composite material such as a molecular fiber matrix and fiberglass composite. Such a material may be water penetrable. Therefore, as shown in FIG. 4B, a thin waterproof layer or film **265** is deposited on the interior surfaces of the hatch **110** so that the film **265** adheres to the underlying surfaces. The film **265** may possibly extend onto the interior surface **255** of the shoulder **235**. Otherwise, the film **265** may extend to the inner edge of the inner surface **255**. The film **265** functions as a part of a water-proof envelope of the compartment **105** when the hatch **110** is fastened in place over the compartment **105** and may be formed of a compliant material such as the Surllyn® material referred to above.

Referring again to FIG. 4A, conduits for elongate communication elements **171** passing into the compartment **105** are accommodated by channels **270** formed in the outer and inner surfaces **250**, **255** of the shoulder **235** of the hatch **110**. Each individual channel **270** is in registration with a corresponding channel **170** in the shoulder **135** of the compartment **105** of FIG. 3A, and the corresponding channels match one another in size. For example, the depth of each channel **270** may be slightly less than about one half of the diameter or thickness of the elongate communication element to be accommodated. The channel **170** faces the bottom half of a corresponding one of the holes **173** in the step **140**, while the channel **270** faces the top half of the corresponding hole **173**. Thus, the diameter of the hole **173** may be on the order of about twice the depth of each channel **170**, **270**. The depths of the matching channels **170** and **270** are preferably the same, so that a conduit or wire accommodated within a pair of facing channels **170**, **270** experiences a top-to-bottom

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even distribution of pressure when the hatch **110** is fastened onto the top of the compartment **105**.

Referring again to FIG. 3A, a sealing gasket **300** comprising a highly conformable layer such as a silicone gel is laid over the inner surface **155**. Referring to FIG. 4A, an identical sealing gasket **300'** is laid over the inner surface **255** of the hatch **110**. The sealing gaskets **300**, **300'** may be of a highly conformable or viscous material, such as a highly conformable silicone gel material. Such a seal is sold by Dow Corning Corporation of Midland, Mich. under the product name "Dow Corning gel seal", specifically the gel seal **1030** product. The structure of such a seal or gasket is depicted in FIG. 5, and includes a gel layer **400** of a viscous or highly conformable and adhesive gel material, a non-adhesive top layer **405** formed of an open-cell foam material, for example. Optionally, an adhesive backing may be provided as a bottom layer **410**. The non-adhesive top layer **405** enables the hatch **110** to be removed from the compartment **105**. As shown in FIG. 6, for the sealing gasket **300**, the top non-adhesive layer **405** covers the gel layer **400** and is the exposed surface of the gasket **300**, and the adhesive backing layer **410** contacts the inner surface **155**. For the sealing gasket **300'**, a top non-adhesive layer **405'** covers a gel layer **400'** and is the exposed surface of the gasket **300'**, and an adhesive backing layer **410'** contacts the inner surface **255**. The non-adhesive layers **405** and **405'** enables the hatch to be removed from the compartment by preventing the two sealing gaskets **300** and **300'** from bonding together. This is because the foam layers **405** and **405'** will not adhere to each other as the gel layers **400** and **400'** would in absence of the non-adhesive layers **405** and **405'**.

It is believed that the ability of the gel layers **400** and **400'** to form a perfect water-tight or air-tight seal in a confined space with corners and edges is attributable to its ductility. A measure of its ductility is the elongation of the material. The Dow Corning gel seal material is believed to have an elongation of 150% or greater. Thus, in one aspect, the gel layers **400** and **400'** may be formed of a deformable material having an elongation of at least 150% or greater.

Referring to FIG. 6, the ridge **160** acts as a positioning reference for the gasket **300**, resisting migration of the gasket **300** toward the periphery. The ridge **260** acts as a positioning reference for the gasket **300'**, resisting migration of the gasket **300'** toward the periphery. The height of the ridge **160** determines the distance by which the gasket **300** is compressed when the hatch **110** is fastened over the compartment **105**. The compression distance is the difference between the thickness of the gasket **300** and the height of the ridge **160**. The height of the ridge **260** determines the distance by which the gasket **300'** is compressed when the hatch **110** is fastened over the compartment **105**. The compression distance is the difference between the thickness of the gasket **300'** and the height of the ridge **260**.

Referring to FIGS. 7A and 7B, it is believed that the conformability of each sealing gasket **300**, **300'** is so great that, as the hatch **110** is compressed toward the compartment **105** (FIG. 7A), firmly pressing the opposing surfaces together (FIG. 7B), the sealing gaskets **300**, **300'** fill in spaces or voids between the elongate communication element **171** and the interior surfaces of the channels **170**, **270**, so that there remains no voids of a sufficiently large size for a molecule of a gas (e.g., oxygen) or of a liquid (e.g., water) to pass through. The ability of each sealing gasket **300**, **300'** to conform to (and fill) the volume defined between the elongate communication element **171** and the interior surfaces of the facing channel **170**, **270** is referred to herein as the conformability of the gaskets **300** and **300'**. The con-

formability may be defined by the size of the smallest molecule excluded by the seal formed by the gaskets 300 and 300' around the elongate communication element 171. This size may be referred to as the exclusion size, and characterizes the conformability of the material comprised within the gaskets 300, 300'. In one embodiment, the exclusion size is equal to or smaller than the size of a water molecule, so that the seal formed by the gaskets 300 and 300' is water-tight. In another embodiment, the exclusion size is equal to or smaller than the size of an oxygen gas molecule, so that the seal is air-tight. Optionally, the water-tightness or air-tightness may be exhibited for a limited period of time (for example, a matter of hours in a range of one to 24 hours), which may vary depending upon the requirements of the system designer. Or, the water-tightness of air-tightness is exhibited for an undefined (unlimited) period of time.

The gel layer 400 and the non-adhesive top layer 405 fill the voids surrounding each elongate communication element 171 by deforming elastically. Such elastic deformation enables each gasket 300, 300' to relax whenever the hatch 110 is removed and to again conformability fill the voids surrounding each conduit when the hatch 110 is re-installed, so that the hatch may be removed and re-installed repetitively to attain a perfect seal upon each re-installation of the hatch 110 over the compartment 105.

High conformability, with exclusion size on the order of a water molecule or oxygen gas molecule, is exhibited by a silicone gel material, such as the Dow Corning gel seal material referred to above. In one embodiment, the sealing gaskets 300 and 300' are each strips of Dow Corning gel seal 3010 material referred to above. However, any other suitable material satisfying the elastic conformability defined above may be employed for the gaskets 300 and 300'.

Referring still to FIGS. 7A and 7B, the deformation of the gaskets 300 and 300' around the elongate communication element 171 is determined by the respective depths of the channels 170 and 270. In an embodiment, each pair of facing channels 170, 270 are of the same depth, so that the opposing compressive forces of the gaskets 300, 300' against the elongate communication element 171 are the same. The distance by which the gaskets 300 and 300' are compressed around the elongate communication element 171 corresponds to the difference between the diameter (or thickness) of the elongate communication element 171 and the sum of the depths of the opposing channels 170 and 270.

In order to prevent migration of the gaskets 300, 300' toward the interior of the compartment 105, the inner surfaces 155, 255 are each sloped at an angle of about 5 degrees in opposite slopes so that the two surfaces 155, 255 ramp away from each other at a combined angle of 10 degree's in a radially outward direction, i.e., toward the periphery or step 140, as shown in the cross-sectional view of FIG. 8. The ramp angle of each of the inner surfaces 155, 255 may not necessarily be 5 degrees, but may lie in an appropriate range (e.g., from about 1 to 10 degrees). The ramp angle of the compartment inner surface 155 determines the height of the ridge 160. The ramp angle of the hatch inner surface 255 determines the height of the ridge 260. The gaskets 300, 300' are confined against migration in an inward direction toward the interior of the compartment 105 by the oppositely sloped inner surfaces 155, 255, and are confined against migration in the opposite (outward) direction by the ridges 160, 260. The ridges 160, 260 thus perform two functions, in that their heights determine the degree to which the gaskets 300, 300' are compressed upon

closure of the hatch 110 over the compartment 105, and because they block migration of the gaskets 300, 300' in the outward direction.

As the hatch 110 pushes the viscous gaskets 300, 300' down the 5 degree ramps of the facing inner surfaces 155 and 255, the gaskets 300, 300' are wedged tighter into corners formed between the elongate communication element 171 and interior surfaces of the pair of facing channels 170 and 270, while the gaskets 300 and 300' are prevented from migrating toward or into the compartment 105. As depicted in FIG. 7C, if the compartment 105 experiences a vacuum, the hatch 110 deflects in such a manner that the oppositely ramped inner surfaces 155, 255 become even more sloped relative to one another, thereby pushing the gaskets 300, 300' more tightly into any corners or voids formed between the elongate communication element 171 and the interior surfaces of the pair of facing channels 170, 270, thus enhancing the sealing action of the gaskets 300, 300' in opposing the forces of such a vacuum.

A plan view of the closed assembly is shown in FIG. 9. FIGS. 10 and 11 are cross-sectional views taken at different locations noted in FIG. 9.

Referring now to FIG. 12A, the fasteners 263 and fastener holes 162 and 262 of FIG. 1 may be replaced by a pair of interlocking gaskets, namely a bottom interlocking gasket 500 bonded to the surface of the shoulder 135 of the compartment 105, and a top interlocking gasket 550 bonded to the surface of the shoulder 235 of the hatch 110. The pair of interlocking gaskets 500 and 550 eliminate the need for the gel seal gaskets 300 and 300' and the associated fasteners of the embodiments described above. The shoulders 135 and 235 may be continuously flat and not sloped. In the illustrated embodiment, the bottom interlocking gasket 500 includes a base 505 having a bottom surface or a bottom adhesion layer 507 bonded to the surface of the shoulder 135. The bottom interlocking gasket 500 further includes a pair of ridges 510, 512 extending from the base 505 and separated by an inner gap 514. The ridge 510 is formed with a barb 520 pointed outwardly with respect to the gap 514, while the ridge 512 is formed with a barb 530 pointed outwardly with respect to the gap 514 and in a direction opposite to that of the barb 520. In the illustrated embodiment, the top interlocking gasket 550 includes a base 555 having a bottom surface or a bottom adhesion layer 557 bonded to the surface of the shoulder 235 of the hatch 110. The top interlocking gasket 550 further includes a pair of ridges 560, 562 extending from the base 555 in a direction toward the bottom interlocking gasket 500, and separated by an inner gap 564. A center alignment nub 575 may be provided in the gap 564. The ridge 560 is formed with a barb 565 pointed inwardly toward the gap 564, while the ridge 562 is formed with a barb 570 pointed inwardly toward the gap 564 and in a direction opposite to that of the barb 565. The ridges 510, 512, 560 and 562 are terminated at respective apexes 510a, 512a, 560a and 562a defined by respective ramped surfaces 510b, 512b, 560b and 562b that slope downwardly from the respective apex 510a, 512a, 560a and 562a to the respective barb 520, 530, 565 and 570. As just described, in this embodiment, the bottom interlocking gasket 500 has a pair of outwardly facing barbs 520, 530 and the top interlocking gasket 550 has a pair of inwardly facing barbs 565, 570. However, in another embodiment this arrangement is reversed, so that the bottom interlocking gasket 500 has a pair of inwardly facing barbs while the top interlocking gasket 550 has a pair of outwardly facing barbs.

In an embodiment, the top and bottom interlocking gaskets 500, 550, are integrally formed of an elastically deform-

able waterproof material. This enables the respective ridges **510**, **512**, **560**, **562** to deform in directions opposite to the directions of their respective barbs **520**, **530**, **565** and **570** whenever the opposing pair of ramped surfaces **510b**, **562b** and the opposing pair of ramped surfaces **512b**, **560b** are pressed together, as shown in FIG. 13, until the opposing barbs capture one another and become locked together, as shown in FIG. 14. FIG. 15 is a plan view corresponding to FIG. 14. In the configuration of FIGS. 14 and 15, the hatch **110** is firmly fastened in place over the compartment **105**, the interlocking gaskets **500**, **550** providing a watertight seal, impervious to penetration by certain gas species (e.g., oxygen gas) or certain liquid species (e.g., water) or both. Because of the elastically deformable property of the interlocking gaskets **500**, **550**, the foregoing deformation sequence may be reversed to remove the hatch **110** from its locked position over the compartment **105**. Such installation and removal of the hatch **110** may be repeated over many cycles, without requiring screws or the like.

Elongate communication elements, such as conduits, wires, tubes or optical fibers, communicating between the compartment **105** and other locations on the craft are accommodated with the interlocking gaskets **500**, **550** by providing a channel **600** in the surface of the shoulder **135** for each elongate communication element, as shown in FIGS. 12A, 12B and 12C. Each channel **600** faces a matching hole or passage **602** open at the surface of the step **140**, the passage **602** providing a path to other locations on the craft for a wire or conduit held in the channel **600**. As indicated in FIGS. 12C and 12D, the channels **600** are formed, and elongate communication elements **610** are laid in the respective channels **600** prior to the installation or bonding of the bottom interlocking gasket **500** onto the shoulder **135**. The channels **600** may be narrow, on the order of the diameter of the elongate communication elements, so as to not detract from the structural integrity of the body **100** in the vicinity of the base of the first interlocking gasket **500**. As depicted in FIGS. 12C and 12D, a bottom gasket **620** is placed under the conduit **610** while a top gasket **630** is placed over the conduit **610** when the conduit **610** is placed in the channel **600**. Thereafter, the bottom interlocking gasket **500** is pressed and bonded onto the surface of the shoulder **135**, thereby compressing the bottom and top gaskets **620**, **630** around the conduit **610** and covering each channel **600**. Each gasket **620**, **630** is formed of (or includes) a material of high conformability, such as (for example) the Dow Corning gel seal material referred to previously herein. As shown in FIG. 12E, the gaskets **620**, **630** fill voids between the conduit or wire **610** and the interior surfaces of the channel **600**, thereby providing a seal around the conduit or wire **610** that is impenetrable by either a liquid (e.g., water) or a gas (e.g., oxygen). The interlocking gaskets **500**, **550** are elongate and mutually parallel, while the channels **600** are elongate and mutually parallel but transverse to the elongate interlocking gaskets **500**, **550**. In the illustrated embodiment, the channels **600** are transverse or perpendicular to the path of the interlocking gaskets **500**, **550**.

FIG. 12C shows the path of cable **610** and the seals **620** and **630** perpendicular to the gasket **500**. However, the path of cable **610** and the seals **620** and **630** can be parallel to the gasket **500**.

While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

What is claimed is:

1. An accessible sealable compartment in a body having an exterior body surface, and comprising:
 - a compartment interior and a compartment sealing surface adjacent a top edge of said compartment interior;
 - a hatch body having a hatch sealing surface congruent with and facing said compartment sealing surface;
 - wherein at least one of the hatch sealing surface and the compartment sealing surface having a congruent channel defined therein;
 - a hatch-to-compartment fastening structure;
 - a gasket between said compartment sealing surface and said hatch sealing surface and disposed in said congruent channel;
 - at least one elongate communication member having a portion lying between said compartment sealing surface and said hatch sealing surface, said at least one elongate communication member extending into said compartment interior from a location outside of said compartment interior via the congruent channel there-through, said channel having a congruent wall conforming to the at least one elongate communication member;
 - wherein said gasket comprising a first viscous gel gasket on said compartment sealing surface continuously around a periphery of the compartment and a second viscous gel gasket on said hatch sealing surface continuously around a periphery of the hatch and wherein said first and second viscous gel gaskets meet to form a watertight seal between the compartment sealing surface and the hatch sealing surface; and
 - wherein at least one of the first or second viscous gel gaskets extends into the congruent wall in the channel.
2. The compartment of claim 1 wherein said viscous gel material has an elongation of 150% or greater.
3. The compartment of claim 1 wherein said viscous gel material has a conformability corresponding to an exclusion size on the order of one of: (a) a liquid molecule, (b) a gas molecule.
4. The compartment of claim 3 wherein one of: (a) said liquid molecule is a water molecule, or (b) said gas molecule is one of an oxygen gas molecule, a nitrogen gas molecule or a carbon dioxide molecule.
5. An accessible sealable compartment in a body having an exterior body surface, and comprising:
 - a compartment interior and a compartment sealing surface adjacent a top edge of said compartment interior;
 - a hatch body having a hatch sealing surface congruent with and facing said compartment sealing surface;
 - a pair of interlocking gaskets interposed between said compartment sealing surface and said hatch sealing surface, said pair of interlocking gaskets comprising a first interlocking gasket on said compartment sealing surface and a second interlocking gasket on said hatch sealing surface, said first and second interlocking gaskets comprising an elastically deformable material;
 - at least one channel in said compartment sealing surface and underlying said first interlocking gasket, said channel in communication with said compartment interior; and
 - at least one elongate communication member having a portion lying in said at least one channel, said at least one elongate communication member extending into said compartment interior from a location outside of said compartment interior.
6. The compartment of claim 5 further comprising a sealing gasket in said channel and surrounding said at least

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one elongate communication member, said sealing gasket comprising an elastically conformable material.

7. The compartment of claim 6 wherein said sealing gasket comprises a first gasket underlying said elongate communication member and a second gasket overlying said elongate communication member.

8. The compartment of claim 6 wherein said elastically conformable material comprises a viscous gel.

9. The compartment of claim 6 wherein said elastically conformable material has a conformability corresponding to an exclusion size on the order of one of: (a) a liquid molecule, (b) a gas molecule.

10. The compartment of claim 9 wherein one of: (a) said liquid molecule is a water molecule, or (b) said gas molecule is one of an oxygen gas molecule, a nitrogen gas molecule or a carbon dioxide molecule.

11. The compartment of claim 6 wherein said elastically conformable material has an elongation of 150% or greater.

12. The compartment of claim 6 wherein said channel has a width corresponding to a diameter of said elongate communication member.

13. The compartment of claim 6 wherein said at least one elongate communication member comprises plural elongate communication members, and wherein said at least one channel comprises plural channels in said compartment sealing surface underlying said first interlocking gasket and said plural elongate communication members in said plural channels, and wherein said sealing gasket comprises plural sealing gaskets in said plural channels and surrounding said plural elongate communication members.

14. The compartment of claim 5 wherein first interlocking gasket comprises elongate inwardly extending barbs and

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said second interlocking gasket comprises elongate outwardly extending barbs matable with said elongate inwardly extending barbs.

15. The compartment of claim 5 wherein first interlocking gasket comprises elongate outwardly extending barbs and said second interlocking gasket comprises elongate inwardly extending barbs matable with said pair of elongate outwardly extending barbs.

16. The compartment of claim 5, wherein said pair of interlocking gaskets are separating said compartment sealing surface and said hatch sealing surface.

17. A water-tight or air-tight accessible compartment comprising a compartment body with a compartment interior and a removable hatch disconnectable from the compartment body and sealed at an edge thereof to an edge of the compartment interior with elastically conformable opposing seals, with elongate communication elements extending into the compartment interior between the opposing seals, said seals conforming to a topology formed between the compartment edge and the elongate communication elements; and

wherein said compartment body comprises a sealing surface comprising a sloped portion, and wherein said removable hatch comprises a sealing surface comprising a sloped portion, and wherein said sloped portion of said sealing surface of said compartment and said sloped portion of said sealing surface of said hatch are ramped with respect to each other so as to open away from each other along a direction away from said compartment interior.

18. The compartment of claim 17 wherein said seals comprise material having an elongation of 150% or greater.

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